Claims

What is claimed is:

1. A tunable light source comprising:

a) an optical parametric amplifier placed in a cavity for performing an optical parametric oscillation involving a signal beam and an idler beam;

b) a pump arrangement for providing a pump beam at a pump frequency to said optical parametric amplifier such that said optical parametric oscillation is driven near degeneracy;

c) an adjustment means for adjusting said pump frequency to select a gain spectrum of said optical parametric oscillation; and

d) a spectral control means for setting a resonant frequency of said cavity within said gain spectrum.

2. The tunable light source of claim 1, wherein said spectral control means comprises a narrowband tuner for setting a passband for said resonant frequency.

3. The tunable light source of claim 2, wherein said narrowband tuner comprises an element selected from the group consisting of a diffraction grating filter, a tunable fiber Bragg grating, dielectric coated mirrors, dielectric coated filters and an etalon filter.

112 OK

4. The tunable light source of claim 3, wherein said passband is set to reject one of said idler beam and said signal beam.

5. The tunable light source of claim 1, wherein said cavity is a multiple axial mode cavity.

6. The tunable light source of claim 5, wherein said cavity is selected from the group consisting of a ring cavity and a standing-wave cavity.

7. The tunable light source of claim 5, wherein said cavity comprises an optical fiber.

8. The tunable light source of claim 5, wherein said cavity has a length of more than 1 meter.

9. The tunable light source of claim 1, wherein said pump arrangement has a wavelength tuning range of about 1.5 nm about degeneracy.

10. The tunable light source of claim 1, wherein said pump arrangement comprises:

a) a light source for producing a primary beam;

b) a second harmonic generator for receiving and frequency doubling said primary beam to produce said pump beam.

11. The tunable light source of claim 10, wherein said second harmonic generator and said optical parametric amplifier are both contained in a nonlinear optical converter.

12. The tunable light source of claim 11, further comprising a wavelength filter for filtering said primary beam, said wavelength filter being positioned between said second harmonic generator and said optical parametric amplifier.

13. The tunable light source of claim 12, wherein said wavelength filter comprises an element selected from the group consisting of a spatial mode filter, a grating, a fiber-Bragg filter, a low pass filter, a directional coupler, a dichroic dielectric mirror, a grating-assisted coupler and an absorptive filter.

14. The tunable light source of claim 11, wherein said second harmonic generator comprises a first quasi-phase-matching grating in said nonlinear optical converter and said parametric amplifier comprises a second quasi-phase-matching grating in said nonlinear optical converter.

15. The tunable light source of claim 14, wherein said first quasi-phase-matching grating is aperiodic.

16. The tunable light source of claim 14, further comprising an optical coupler between said first quasi-phase-matching grating and said second quasi-phase-matching grating.

17. The tunable light source of claim 10, wherein said pump arrangement further comprises an optical amplifier for amplifying said primary beam.

18. The tunable light source of claim 1, wherein said optical parametric amplifier further comprises a quasi-phase-matching grating for phase matching said optical parametric oscillation.

19. The tunable light source of claim 18, wherein said quasi-phase-matching grating is distributed in a waveguide.

20. The tunable light source of claim 1, further comprising an output coupler for out-coupling at least one of said signal beam and said idler beam.

21. The tunable light source of claim 1, further comprising a wavelength sweep control for coordinating the adjustment of said pump frequency and selection of said resonant frequency, such that said resonant frequency sweeps across a wavelength window.

22. The tunable light source of claim 21, wherein said wavelength window comprises at least 100 nm.

23. The tunable light source of claim 21, wherein said spectral control means comprises a narrowband tuner for setting a passband for said resonant frequency, said passband ranging from 0.1 pm to 1000 pm.

24. The tunable light source of claim 1, further comprising a synchronizing unit connected to said pump arrangement for synchronizing said pump beam with a round-trip time of said cavity.

25. A swept wavelength system with a tunable light source comprising:

a) an optical parametric amplifier placed in a cavity for performing an optical parametric oscillation involving a signal beam and an idler beam; and

b) a pump arrangement for providing a pump beam at a pump frequency to said optical parametric amplifier

such that said optical parametric oscillation is driven near degeneracy.

26. The swept wavelength system of claim 25, further comprising:

a) an adjustment means for adjusting said pump frequency to select a gain spectrum of said optical parametric oscillation; and

b) a spectral control means for setting a resonant frequency of said cavity within said gain spectrum.

27. The swept wavelength system of claim 26, further comprising a wavelength sweep control for coordinating adjustment of said pump frequency and selection of said resonant frequency, such that said resonant frequency sweeps across a wavelength window.

28. The swept wavelength system of claim 27, wherein said wavelength window comprises at least 100 nm.

29. The swept wavelength system of claim 27, wherein said wavelength window is centered at approximately 1550 nm.

30. The swept wavelength system of claim 26, wherein said spectral control means comprises a

narrowband tuner for setting a passband for said resonant frequency, said passband ranging from 0.1 pm to 1000 pm.

31. The swept wavelength system of claim 26, wherein said spectral control means comprises a narrowband tuner for setting a passband for said resonant frequency.

32. The swept wavelength system of claim 31, wherein said narrowband tuner comprises an element selected from the group consisting of a diffraction grating filter, a tunable fiber Bragg Grating, dielectric coated mirrors, dielectric coated filters and an etalon filter.

33. A swept wavelength system with a tunable light source comprising:

a) a nonlinear optical converter placed in a cavity for performing a nonlinear frequency conversion, said nonlinear optical converter having a quasi-phase-matching grating for phase matching said nonlinear frequency conversion;

b) a pump arrangement for providing a pump beam at a pump frequency to said nonlinear optical converter for performing said nonlinear frequency conversion;

c) an adjustment means for adjusting said pump frequency to select a gain spectrum of said nonlinear frequency conversion; and

d) a spectral control means for setting a resonant frequency of said cavity within said gain spectrum.

34. The swept wavelength system of claim 33, wherein said nonlinear optical converter comprises an optical parametric amplifier and said nonlinear frequency conversion comprises an optical parametric oscillation involving a signal beam and an idler beam.

35. The swept wavelength system of claim 34, wherein said nonlinear optical converter further comprises a second harmonic generator.

36. The swept wavelength system of claim 34, wherein said pump arrangement drives said optical parametric oscillation near degeneracy.

37. The swept wavelength system of claim 33, wherein said pump arrangement comprises:

a) a light source for producing a primary beam;

b) a second harmonic generator for receiving and frequency doubling said primary beam to produce said pump beam.

38. The swept wavelength system of claim 37, wherein said nonlinear optical converter comprises an optical parametric amplifier and both said second harmonic generator and said

optical parametric amplifier are contained in said nonlinear optical converter.

39. The swept wavelength system of claim 38, further comprising a wavelength filter for filtering said primary beam, said wavelength filter being positioned between said second harmonic generator and said optical parametric amplifier.

40. The swept wavelength system of claim 33, wherein said quasi-phase-matching grating is distributed in a waveguide.

41. A method for tuning a light source comprising an optical parametric amplifier, said method comprising:

a) placing said optical parametric amplifier in a cavity;

b) producing a pump beam having a pump frequency;

c) delivering said pump beam to said optical parametric amplifier for driving an optical parametric oscillation near degeneracy, said optical parametric oscillation involving a signal beam and an idler beam;

d) adjusting said pump frequency to select a gain spectrum of said optical parametric oscillation; and

e) setting a resonant frequency of said cavity within said gain spectrum.

42. The method of claim 41, wherein said resonant frequency is controlled by establishing a passband for at least one of said idler beam and said signal beam.

43. The method of claim 42, wherein said passband comprises between 0.1 pm and 1000 pm.

44. The method of claim 41, wherein said pump frequency is selected in a wavelength tuning range extending approximately 1.5 nm from said degeneracy.

45. The method of claim 41, further comprising removing one of said signal beam and said idler beam.

46. The method of claim 41, wherein said pump beam is a continuous-wave beam.

47. The method of claim 41, wherein said pump beam is a pulsed beam.

48. The method of claim 47, wherein said pulsed beam has a duty cycle ranging from 1% to 50%.

49. The method of claim 47, wherein said pump beam is synchronized with a round-trip time of said cavity.

50. The method of claim 41, further comprising generating said pump beam from a primary beam.

51. The method of claim 50, wherein said step of generating comprises a second harmonic generation.

52. The method of claim 41, wherein said pump frequency is shifted when said optical parametric oscillation is within an offset from degeneracy.

53. The method of claim 52, wherein said resonant frequency is confined to a passband and the wavelength separation between said signal beam and said idler beam is maintained at least equal to said passband.

54. The method of claim 52, wherein said offset ranges between about 50 pm and 500 pm.

55. A swept wavelength system with a tunable light source comprising:

a) a nonlinear optical converter for performing a nonlinear frequency conversion, said nonlinear optical converter having a quasi-phase-matching grating for phase matching said nonlinear frequency conversion;

b) a pump arrangement for providing a pump beam at a pump frequency to said nonlinear optical converter for performing said nonlinear frequency conversion;

c) an adjustment means for adjusting said pump frequency to select a gain spectrum of said nonlinear frequency conversion; and

d) a spectral control means for setting an output frequency within said gain spectrum.

56. The swept wavelength system of claim 55, wherein said nonlinear optical converter is placed within a cavity and said output frequency set by said spectral control means is a resonant frequency of said cavity.

09863842.052201